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AUTHOR Menninger, Sally; Rose, Clare
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ABSTRACT

This report presents the results of a study of the employment and enrollment patterns of women scientists and engineers conducted by the Evaluation and Training Institute with assistance from the National Science Foundation, and compares them to the results of other studies. Overall, the distributions of both women and students across the various disciplines in the study sample reflected the traditional patterns of career interests of women in the sciences, and was representative of findings reported from other studies. Women have been, and continue to be, concentrated in the life sciences, the social sciences, and psychology; they have been, and continue to be, least visible in the technical disciplines such as engineering and physical sciences. However, graduate enrollment figures show increasing numbers of women entering the technical areas in the past five years. In the social sciences, women were almost equally represented in small and large schools, accounting for 2% in the small schools and 20% of the employee force in the large schools. Another significant pattern was a concentration of women employees in high prestige departments. (Author/BB)

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WOMEN SCIENTISTS IN ACADEME: THE NUMBERS AND WHAT THE NUMBERS DON'T SAY

Sally Menninger and Clare Rose
Evaluation and Training Institute

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Women have received 12% of the Ph.D's in chemistry granted by Harvard University since 1953. Between 1953 and 1978, 401 men and 55 women chemists received their doctorates from this prestigious school. Of these fifty-five women, 23 are now working in universities and colleges, six are employed in private research laboratories, and seven are in private industry. Nineteen of the fifty-five women, 35% of them, have disappeared. They have been reported as "not known to be pursuing scientific careers".

Harvard did not track the 401 men who received their degrees during the same period, so we don't know how the career development of this group of women compares with their male colleagues. But nineteen out of fifty-five seems like a tremendous loss. What happened to these nineteen women? Why didn't they continue on in chemistry or in some related scientific pursuit?

The study of the employment and enrollment patterns of women scientists and engineers, conducted by the Evaluation and Training Institute with the assistance of grants from the National Science Foundation, explored the world of women scientists in academe, and the data provides some clues to the disappearance of these women. The academic environment is an important context in which the career patterns of women scientists and engineers can be examined. Research has shown that the majority of women who receive ad-

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vanced degrees in the sciences pursue careers in educational institutions. In addition, a woman's experiences in graduate school are critical to her later professional development regardless of her specific career choice.

The ETI study consisted of two parts. The first was composed of a series of statistical analyses of institutional and departmental trends in women's graduate enrollment and employment in science and engineering in the fifty leading doctorate-granting institutions in the United States. These fifty schools reported the greatest number of full-time scientists and engineers employed full-time in the 1976 Survey of Scientific and Engineering Personnel Employed at Universities and Colleges conducted by NSF. The second part of the study involved site visits to nine of the fifty schools. Deans, department chairs, faculty, research staff and students in a variety of scientific disciplines were interviewed and questioned regarding the numbers, status, and experiences of women scientists. The case study institutions were by design a mixed group, selected to provide diversity with respect to geographic location, urban versus rural environment, institutional size, source of support (that is, public or private), and the proportion of women scientists employed. The final case study sample consisted of nine schools: the University of Arizona; Harvard University; Louisiana State University, Baton Rouge; the University of Michigan; Northwestern University; Purdue University; the University of Southern California; Texas A & M University; and the University of Washington.

The principal data sources for the study were the annual surveys conducted by the National Science Foundation on employment and graduate student enrollment in the sciences and engineering, which are part of NSF's university statistics program. This program has produced an extensive source of data on graduate student enrollment and support, federal obligations to academic institutions, research and development expenditures among colleges and universities, and the employment of scientific and technical personnel. The 1976 annual Survey of Scientific and Engineering Personnel Employed at Universities and Colleges used in this study included data from over 2300 institutions, including two year colleges, which offered degree credit courses in the sciences and engineering. The 1975 Survey of Graduate Science Student Support and Postdoctorals used for enrollment data included reports from approximately 8000 departments in over 360 institutions.

The main intent of the NSF surveys is to provide manpower data essential to the formulation of policies and programs to assure the effective utilization of scientists and engineers in this country. The duty of monitoring the supply of scientific manpower resources was given to NSF in 1959 by the Office of Management and Budget. However, it has only been within the past 7 years, since 1971, that NSF began requesting a breakdown by sex on employees and graduate students in the different scientific fields. Although seven years does not seem like a long time, NSF in fact spearheaded the collection of information on the numbers and status of women scientists. Most profession-

al scientific societies and organizations began to take specific interest in the women in their ranks only within the past 3 to 5 years. The American Chemical Society, for instance, began comparative surveys of its male and female membership in 1973, only 5 years ago. The recent efforts of this professional organization, and others such as the Society of Women Engineers and the American Institute of Biological Sciences, have made women scientists more visible in the scientific community and increased the awareness of women's potential among employers.

Yet the statistical data which has resulted from the surveys conducted by these various groups presents a problem to the researcher interested in defining the status of women scientific professionals. Different surveys ask different questions and use different formats, so data on women in one field cannot be compared with data resulting from a study in another field. And in their zeal to put women in the spotlight, the designers of some surveys have neglected to collect information about men, so there are no comparison groups or standards available to determine the status of women with respect to salaries, employment opportunities, career advancement, and other variables.

The ETI study of women scientists represents a step toward a more comprehensive and integrated view of the status of women scientific professionals. The statistical analyses performed in this study used data on women and men from eight scientific fields: engineering, environmental science, physical science, life science, medical science, mathematics, social science and psychology. Since a variety of fields was included, the results of the study

are more justifiably generalizable to women scientists as a group, since that group contains women with a diversity of professional interests. In addition, enrollment and employment patterns specific to one field could be identified through comparisons with patterns in other areas.

The results of the NSF survey are aggregated at the institutional level. Each school reports counts of men and women employed and enrolled in the various scientific fields. In reporting to NSF, a school includes research assistants, postdoctorals and other non-faculty scientific staff along with faculty members in its employee count. As such the ETI study was not confined to women faculty, but included women in a variety of academic positions.

The statistical analyses of the study were structured to determine if the distributions of men and women differed significantly with respect to six institutional variables: geographical region; source of institutional support; size of institution, measured first by student body count and second by employee count; instructional emphasis of the school (that is, whether it is oriented toward research or teaching; and prestige ranking of department. Since the data was in the form of counts, the chi square statistic was used to compare the distributions.

The total employee count in all fields in our sample of schools was approximately 77,000 of which 16.4% were women. The proportion of women varied from field to field with a high of 25% in psychology to a low of 3% in engineering. The fifty schools reported a graduate student count of approximately

108,000, of which 24% were women. The distribution of women students across the different fields parallels the distribution of women employees. Graduate women were most visible in psychology where they constituted 45% of the graduate student count, and least visible in engineering, where only 5% of the students were women.

Overall, the distributions of both women and students across the various disciplines in the study sample reflected the traditional patterns of career interests of women in the sciences, and as such was representative of findings reported from other studies. Women have been, and continue to be, concentrated in the life sciences, the social sciences, and psychology; they have been and continue to be least visible in the hard-core, technical disciplines such as engineering and the physical sciences. With regard to the figures for graduate enrollment, however, there are significant and encouraging increases in the number of women entering the hard sciences in the past 5 years. In our sample from 1976, 5% of the graduate students in engineering were women. Yet, relative to the figure of 2.2% for graduate women's enrollment in 1973, only 3 years earlier, 5% represents a dramatic increase. How many of these women will complete their degrees and go on to pursue professional careers in these fields remains to be seen, but at least more and more women are demonstrating their interest in non-traditional careers and are receiving the necessary training for such careers.

This paper will focus on two significant employment patterns which emerged from the analyses. First, contrary to the literature on women academics generally, women scientists are concentrated in the very largest institutions. Although our sample of 50 schools accounted for only 2% of the institutions surveyed by NSF, these 50 schools, which are the largest in terms of size of scientific personnel force, employed 47% of all women reported by all 2,700 institutions included in the survey. And when these 50 schools were further categorized as large, medium or small within the study analyses, the highest concentration of women was found in the very largest schools while the smallest percentage of women was found in the small schools. In large schools, those with a scientific employee population of more than 1,650, women constituted 18% of the total employee count, while in small schools, those with an employee population of less than 1,250, women constituted 14% of the total (see Table 1). This pattern held consistently in six of the eight fields, the two exceptions being the life sciences and the social sciences.

In the social sciences women were almost equally represented in small and large schools, accounting for 21% of the employee force in small schools and 20% in the large schools. This distribution was similar to the distributions that resulted in all fields when the number of students was used as the measure of institutional size, rather than the size of employee population (see Table 2). When size of student body is used as the criter-

ion, for all fields combined, women are found in equal proportions in large and small schools. In both categories they account for 18% of the employees, while in medium sized institutions their proportion drops to 14%. This pattern is consistent across all fields, with the exception of the life sciences.

The difference in the distributions resulting from the different measures of size may be a reflection of the type of positions women hold in different sized schools. The prevalent notion in the literature is that women teachers are concentrated in smaller schools. As mentioned earlier, the NSF data does not categorize employees as faculty or non-faculty; both are included in the employee count, so there is no direct way of determining if the higher numbers of women found in small schools when student body size is the criterion are in fact teaching staff. But student body size is a correlate of faculty size, and most likely a better correlate than total size of employee population, particularly in large research universities where greater resources are allocated for research. The change in the distributions when the two different measures are used provides indirect evidence suggesting that women scientists on teaching staffs may be concentrated in smaller schools.

The inconsistent distribution found in the social sciences when employee size is the criterion lends further support to this interpretation. Contrary to the pattern in other fields where they are most visible in large schools, women in the social sci-

ences are most prominent in small schools when employee size is the criterion. This distribution may be a function of differences in the work activities of social scientists as compared to those in other scientific fields. A college or university would be less likely to hire a sociologist or economist as a pure researcher than a physicist or chemist. Rather, most social scientists are probably required to teach in addition to doing research. The inconsistent pattern for the social sciences then seems consistent: Women social scientists are most likely engaged in some form of teaching, and as instructional staff they are in greater numbers employed in smaller schools.

Within the limits of the NSF data, there is no direct way to determine if the distributions of women scientists across different sized institutions are related to work activity, whether it be research or teaching. The statistical analysis does suggest a pattern, however, which deserves further exploration. Are women scientists engaged in teaching concentrated in smaller schools, and if so, why? These questions need to be explored in other studies.

The second significant pattern discovered in our analyses was a concentration of women employees in high prestige departments within the sample of schools. This finding is in keeping with a recent study by Cartter and Ruhther (1976) of the prestige level of the first job placement of women doctorates. Cartter and Ruhther concluded that by 1973 "equity had been achieved

between men and women with respect to their first job placement". Using the Roose-Anderson 1970 quality ranking scheme of graduate programs, these researchers divided institutions into five levels of prestige, and reported that by 1973 a larger percentage of women doctorates than men were being placed in the top three categories of schools. Approximately 20% of the women found employment in these top categories as compared to 16% of the men in 1973. These percentages do not mean, however, that women were getting more jobs in prestige schools. Rather, the steady decline of job opportunities in academe during the early seventies hit men more severely, while women continued to be hired at the same rate as in past years, presumably because of affirmative action programs.

Our analyses also showed that women were being employed in the top-ranked institutions in large numbers. Using the Roose-Anderson scheme, we categorized departments rather than institutions in five fields according to a three-level prestige ranking. The fields for which we were able to derive ranking schemes were engineering, physical science, mathematics, life science, psychology, and social science (see Table 3). Across all fields, the percentage of women employees in high quality departments is greater than the percentage of men. In the case of engineering a field which has just recently begun to show strong increases in the number of entering women, the differences in the distributions of men and women across the different quality rankings is striking. Eighty-eight percent of the women employees, compared

to 57% of the men, were in the top-ranked engineering departments. In the physical sciences there is also a striking difference in the distributions, with 65% of the women in top-ranking departments compared to 53% of the men.

The concentration of women in high quality departments in engineering and the physical sciences seems even more striking when these distributions are compared to the distributions of men and women in psychology and the social sciences. Within the study sample, women were generally found in small proportions in engineering, where they accounted for 3% of all employees, and the physical sciences, where they accounted for 6% of the total. In psychology and the social sciences, however, they were relatively well represented, accounting for 25% of the employees in psychology and 19% of those in the social sciences. In examining the distributions of women across the different quality rankings of departments in these fields, the distribution of women was found not to differ greatly from the distribution of men. In psychology the distributions are identical, while in the social sciences 50% of the women are found in the top-ranked departments compared to 46% of the men. It appears, then, that as the number of women increases within a discipline, their distribution across different quality schools grows more similar to the distribution of men.

This finding is subject to alternative kinds of speculation. Cound it be that women who pursue careers in engineering and the

physical sciences, traditionally male strongholds, are of necessity brighter or higher achievers than women who enter psychology, where women are found in larger numbers and have traditionally been accepted? Or could it be that the combination of affirmative action pressures from the federal government and the small proportion of women in the hard sciences have made it a "seller's market" for women in these fields? Highly-rated schools would have an advantage in the competition for women employees, and they may have been able to recruit the largest proportion of women in these fields. Again, further exploration of this pattern should be undertaken in future studies.

Whatever the dynamics behind the higher percentages of women employees in top-ranked schools and departments, the figures do seem encouraging. Women scientists are not at the bottom of the barrel in academe -- or are they? An important variable is missing in both our analyses and the Cartter and Ruhther study: the types of positions held by women are not identified. There are greater numbers of women in prestigious schools, but how prestigious are their jobs?

The NSF survey results could not provide the answer, since data is not gathered concerning rank or position. Past research on women in higher education indicates that academic women have been clustered in the lower faculty ranks. In Ladd and Lipset's (1976) study of faculty, women were found to hold 41% of the instructor positions, 40% of the lectureships and 29% of the as-

sistant professor positions, but only 17% of the associate professorships and 10% of the full professorships. But our data included non-faculty women, and there has not been a great emphasis upon researching their status.

The site visits conducted during the second phase of ETI's study allowed us to probe behind the numbers in order to more fully understand the place of women scientists in academe. The statistics gathered by NSF and other organizations provide an indicator of the science manpower resources in colleges and universities, but they mask the reality of women scientists' positions. According to data gathered from site visit institutions, large numbers of women reported as full-time scientists and engineers on the NSF survey and for compliance with the affirmative action programs of HEW, hold off-ladder, non-tenured, research scientist appointments -- often "soft" money positions funded by extramural grants, not out of general university funds. These women must either find their own grants, or, at institutions where people in these positions are not allowed to pursue grants by themselves, locate a "qualified" principal investigator who will write them into their proposal in order to retain their employment; they lack the security and status of a regular position.

Identifying the factors responsible for the disproportionate number of women in non-tenured research positions is not a simple task. For some women, a research position is a voluntary and satisfactory choice. Vestiges of nepotism laws also remain.

Many of these women were married to men on the faculty and were denied faculty appointments because their husbands were also employed in the department. Other graduate women who had received their doctorates at the institution where their husbands were employed found themselves ineligible for faculty ladder positions because of the "we never hire our own" policy. This policy is basically not discriminatory and is beneficial in preventing inbreeding. Nevertheless, in practice it discriminates against women.

Research scientist positions do not carry the prestige or high status of regular faculty positions. Even worse, they hinder professional development if they are held for a long period of time. Rarely are tenured faculty appointments made from among an institution 's lecturers or research scientists, and seldom are these people recruited by other universities, particularly if they have held this type of appointment for more than a few years. We found one exception to this situation -- a world famous woman scientist credited with significantly advancing her field had been given a full professorship after serving more than 20 years as a research scientist, long after she had become an acknowledged leader in her field.

This study of the status of women scientists in academe has produced mixed results. It is encouraging to see increasing numbers of women receiving graduate training in scientific fields, and women scientists are finding employment in large and pres-

tigious schools. But within these schools they are not able to follow the traditional path for a scientific career in academe. They are concentrated in the lower ranks of the faculty ladder and in off-track research positions. Perhaps these positions allow those women interested in combining a career and marriage the flexibility to do so. However, at the same time these positions mean lower salaries, less status, and less opportunity for professional growth and development

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Table 1. Women employees as a percentage of total employee population within each category of faculty size, by field

Field of Specialization	Size of Employee Population			Overall Percentage	Chi Square	Level of Significance
	small less than 1250	medium 1251-1649	large more than 1650			
Engineering	.01	.02	.05	.03	87.15	.001
Physical Science	.04	.06	.07	.06	20.77	.001
Environmental Science	.04	.04	.07	.06	8.99	.05
Math	.08	.09	.10	.10	3.2	NS
Social Science	.21	.16	.20	.19	25.14	.001
Life Science	.17	.22	.19	.20	37.58	.001
Medical Science	.16	.21	.24	.22	106.34	.001
Psychology	.18	.28	.28	.25	23.18	.001
All Fields	.14	.17	.18	.16	117.16	.001

Since the chi square test is dependent upon sample size, our interpretation of the chi square values was made in the context of a careful examination of the corresponding percentage distributions of men and women resulting from the breakdown of the data by the criterion variables. The employee counts were large, even within the various fields, and significant chi square values resulted in some cases in which comparison of the distributions of men and women showed little difference. The focus in examining the chi square tables was not on specific values, however, but on the identification of general patterns or trends.

Table 2. Women employees as a percentage of total employee population within each category of student body size, by field

Field of Specialization	Size of Student Body			Overall Percentage	Chi Square	Level of Significance
	small less than 16,000	medium 16,000-30,000	large more than 30,000			
Engineering	.03	.01	.05	.03	58.95	.001
Physical Science	.06	.04	.08	.06	22.95	.001
Environmental Science	.06	.04	.08	.06	10.32	.01
Math	.06	.10	.10	.10	9.84	.01
Social Science	.23	.17	.19	.19	23.10	.01
Life Science	.22	.17	.24	.20	243.01	.001
Medical Science	.22	.16	.28	.22	273.40	.001
Pyschology	.29	.21	.28	.25	12.90	.01
All Fields	.18	.14	.18	.16	196.82	.001

Table 3. Percentage of distribution of women employees compared to distribution of men employees by prestige ranking of department, by field

Field of Specialization	Prestige Ranking			Chi Square	Level of Significance
	high	medium	low		
Engineering					
Women	.88	.09	.03	79.22	.001
Men	.57	.29	.14		
Physical Science					
Women	.65	.22	.12	20.63	.001
Men	.53	.29	.18		
Math					
Women	.56	.16	.28	3.41	NS
Men	.55	.18	.28		
Social Science					
Women	.51	.15	.35	10.44	.01
Men	.46	.16	.38		
Life Science					
Women	.63	.19	.17	172.42	.001
Men	.57	.19	.23		
Psychology					
Women	.59	.25	.16	.10	NS
Men	.59	.25	.15		